Verification of the method to reconstruct histories of crustal uplift rate from river longitudinal profiles: Application to the central part of Boso Peninsula, Japan

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A method for estimating spatial and temporal histories of crustal uplift rate from longitudinal river profiles was proposed by Roberts and White (2010). When bedrock is uplifted, an abrupt change in gradient (i.e., knickpoint) occurs along the river bed, and then subsequent erosional processes cause upstream-migration of knickpoints. Therefore, river longitudinal gradient change reflects the history of uplift rate of bedrock, where older history is recorded in the upstream region. For analyzing river longitudinal profiles, a forward model that calculates incisional processes of river profiles from uplift rate histories with four erosional parameters was developed. Then, the inverse algorithm that minimizes the misfit between calculated and observed river profiles by optimizing uplift rates and erosional parameters was produced to obtain spatial and temporal patterns of regional uplift rate histories. This method is superior to other existing methods for estimating spatial variation of bedrock uplifting rate, and has been applied on profiles of rivers in stable continental regions (e.g., Africa and Australia). However, it has not been tested to tectonically active regions such as the Japan Islands.
Here, we aim to verify the method for analyzing river profiles in tectonically active regions where the uplifting rates of bedrock varies in smaller spatial and temporal scales. We investigated uplift rate histories of the central part of the Boso Peninsula in Japan, and examined the effectiveness of the method, comparing results of multiple rivers that locate in same region. As a result, we found that the uplift rate histories estimated from multiple rivers were inconsistent each other although they locate on the same tectonic terrain. We infer that cause of this inconsistency in estimated uplifting histories can be attributed to the heterogeneity in erodibility of the bedrock in the study area. The forward model employed in this study assumes that the erodibility of bedrock is constant in space; however, several knickpoints actually locate at the lithological boundaries, suggesting the possibility that variation in erodibility should be taken account in the model. Thus, we suggest that parameterization of physical controls such as lithologic variation is significant in order to improve the method to estimate uplift rate histories from longitudinal river profiles in tectonically active regions.

Keywords: river longitudinal profile, inverse analysis, erosion

